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TENT COOPERATION TRE Y

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Assistant Commissioner for Patents
United States Patent and Trademark Office
Box PCT
Washington, D.C.20231
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 20 March 2000 (20.03.00)	
International application No. PCT/CA99/00716	**Applicant's or agent's file reference** 571-578
International filing date (day/month/year) 05 August 1999 (05.08.99)	**Priority date** (day/month/year) 05 August 1998 (05.08.98)
Applicant GUEVREMONT, Roger et al	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International Preliminary Examining Authority on:

21 February 2000 (21.02.00)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

[ ] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO **34, chemin des Colombettes** **1211 Geneva 20, Switzerland**	Authorized officer Jean-Marc Vivet
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38

Form PCT/IB/331 (July 1992)

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PATENT COOPERATION TREATY

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REC'D 29 NOV 2000

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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

15

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
571-578		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/CA99/00716	05/08/1999	05/08/1998

International Patent Classification (IPC) or national classification and IPC
G01N27/64

Applicant
NATIONAL RESEARCH COUNCIL CANADA et al.

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 8 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 6 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☒ Certain documents cited
   - VII ☒ Certain defects in the international application
   - VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
21/02/2000	27.11.2000
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Papantoniou, E Telephone No. +49 89 2399 2468

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/CA99/00716

I. Basis of the report

1. This report has been drawn on the basis of *(substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments (Rules 70.16 and 70.17).)*:
Description, pages:

1,4-24	as originally filed			
2,3	as received on	09/11/2000	with letter of	09/11/2000

Claims, No.:

1-19	as received on	09/11/2000	with letter of	09/11/2000

Drawings, sheets:

1/17-17/17	as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

   These elements were available or furnished to this Authority in the following language: , which is:

   - ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
   - ☐ the language of publication of the international application (under Rule 48.3(b)).
   - ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

   - ☐ contained in the international application in written form.
   - ☐ filed together with the international application in computer readable form.
   - ☐ furnished subsequently to this Authority in written form.
   - ☐ furnished subsequently to this Authority in computer readable form.
   - ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
   - ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:
- ☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

   (Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1 - 19
	No:	Claims	
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1 - 19
Industrial applicability (IA)	Yes:	Claims	1 - 19
	No:	Claims	

2. Citations and explanations
   see separate sheet

VI. Certain documents cited

1. Certain published documents (Rule 70.10)

and / or

2. Non-written disclosures (Rule 70.9)

   see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the

claims are fully supported by the description, are made:
see separate sheet

Re Item V

Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Reference is made to the following documents:

D1: RIEGNER ET AL: "Qualitative evaluation of field ion spectrometry for chemical warfare agent detection" PROCEEDINGS OF THE 45TH ASMS CONFERENCE ON MASS SPECTROMETRY AND ALLIED TOPICS , June 1997 (1997-06), pages 473a-473b, XP000865529 cited in the application
D2: BURYAKOV ET AL.: "A new method of separation of multi-atomic ions by mobility at atmospheric pressure using a high-frequency amplitude asymmetric strong electric field" INTERNATIONAL JOURNAL OF MASS SPECTROMETRY AND ION PROCESSES., vol. 128, 1993, pages 143-148, XP000865595 ELSEVIER SCIENTIFIC PUBLISHING CO. AMSTERDAM., NL ISSN: 0168-1176
D3: CARNAHAN B. ET AL.: "Field ion spectrometry - a new analytical technology for trace gas analysis" PROCEEDINGS OF THE 41ST ISA ANALYSIS DIVISION SYMPOSIUM , vol. 29, 21 - 24 April 1996, pages 85-94, XP000863733
D4: US 5 420 424 A (CARNAHAN BYRON L ET AL) 30 May 1995 (1995-05-30).
D5: HUDGINS R R ET AL: "High resolution ion mobility measurements for gas phase proteins: correlation between solution phase and gas phase conformations" INTERNATIONAL JOURNAL OF MASS SPECTROMETRY AND ION PROCESSES,NL,ELSEVIER SCIENTIFIC PUBLISHING CO. AMSTERDAM, vol. 165-166, page 497-507 XP004103206 ISSN: 0168-1176

2. Claim 1

D2, which is considered as the closest prior art, discloses a method for identifying ions. The method according to D2 comprises the steps of:
- providing at least one ionization source for providing ions (see the ionization chamber of Fig. 2, D2);
- providing an analyzer region defined by a space between at least a first and a second spaced apart electrodes, said analyzer region being in communication with a gas inlet, a gas outlet, an ion inlet and an ion outlet, and introducing said ions into said analyzer region through said ion inlet (see the ion separator of Fig. 2, D2);

- applying an asymmetric waveform voltage (of Fig. 1, D2) and a direct current compensation voltage (for producing E_C of equation 4 of page 145, left column, D2) to at least one of said electrodes;
- setting said asymmetric voltage (e.g. setting $E_S(t)$ of equation 4 of page 145, left column, D2);
- varying said direct current compensation voltage (see page 145, left column, lines 1 - 10, and eq. 6, D2) and measuring resulting transmitted ions at said ion outlet, so as to produce a compensation voltage scan for said transmitted ions (see page 145, left column, last paragraph, D2);
- identifying peaks in said compensation voltage scan (see Fig. 3, D2); and
- setting said direct current compensation voltage to correspond to one of said peaks (see page 146, left column, last paragraph, D2), so as to separate and enrich a desired ion (see page 147, right column, last paragraph, D2).

Although present claim 1 defines that the present method is suitable "for identifying isotopes" and is used "to separate and erich a desired isotope", while D2 is used for identifying and separating ions in general, nonetheless, the method of ion separation according to D2 is also suitable for isotope identification. Specifically since D2 states that it provides an improved method of ion separation even for ions with similar masses (see page 145, right column, last paragraph, D2), it would be obvious to the skilled person to use the method of D2 also for isotopes, specially as present claim 1 does not define any new method steps specifically used for isotopes.

Thus the subject matter of claim 1 is not inventive (Article 33(3) PCT).

3. It is also noted that the particular method steps, e.g. steps a - f, defined in present claim 1 are also known from the other search report documents D1, D3 and D4. See e.g. D1, Fig. 1 and 3 and page 473B, first two paragraphs, D1; D3 Fig. 2 and the two voltages shown in Fig. 1, D3; D4, columns 7 and 8, D4.

4. Claim 10
D2, which is considered as the closest prior art, discloses a method for separating ions (see the title of D2). The method according to D2 comprises the steps of:
a) providing at least one ionization source of ions (ionization chamber of Fig. 2,

D2);
b) providing an analyzer region (ion separator of Fig. 2, D2) defined by a space between at least a first and a second spaced apart electrodes, said analyzer region being in communication with a gas inlet (inlet of Fig. 2, see also page 144, right column, last paragraph, D2), a gas outlet (ion collector of Fig. 2, D2), an ion inlet and an ion outlet, and introducing said ions into said analyzer region through said ion inlet (see Fig. 2, D2);
- applying an asymmetric waveform voltage (of Fig. 1, D2) and a direct current compensation voltage (for producing E_c of equation 4 of page 145, left column, D2) to at least one of said electrodes;
- setting said asymmetric voltage (e.g. setting $E_s(t)$ of equation 4 of page 145, left column, D2);
- setting said direct current compensation voltage to a determined value (e.g. setting E_c of equation 4 of page 145, left column, D2) to separate the ions (see Fig. 3, D2).

Although present claim 10 defines that the present method is suitable "for separating and enriching ions of different isotopic composition", while D2 does not explicitly define such enrichment, nonetheless, D2 states that it provides an improved method for separating homologous ions (see page 148, section "Conclusions", D2). Thus the skilled person would find it obvious to use the method of D2 "for separating and enriching ions of different isotopic composition".

Thus the subject matter of claim 10 is not inventive (Article 33(3) PCT).

6. Dependent claims 2 - 9, 11 - 19, do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of inventive step, the reasons being as follows:

The method steps of claims 2, 6, 15, 19, are known from D1.
The method steps of claims 4, 11, are known from D2.
The method steps of claims 3, 4, 12 are known from D4 and D5 (see Fig. 1, D5).
The method steps of claims 4, 5, 13, 14 are known from D2 and D5.
Claims 7 - 9, 16 - 18, do not define concrete method steps but rather define what ions are investigated. Such wording is not inventive (Article 33(3) PCT).

Re Item VI
Certain documents cited

The claimed priority could not be checked. It is therefore noted that in case the priority is not valid, document GUEVREMONT R ET AL: "High field asymmetric waveform ion mobility spectrometry-mass spectrometry: an investigation of leucine enkephalin ions produced by electrospray ionization" JOURNAL OF THE AMERICAN SOCIETY FOR MASS SPECTROMETRY,US,ELSEVIER SCIENCE INC., NEW YORK, NY, vol. 10, no. 6, page 492-501 XP004173039 ISSN: 1044-0305, could be used against the novelty or inventive step of the present claims.

Re Item VII
Certain defects in the international application

For the sake of completeness, it is mentioned that the requirements of Rule 6.3(b) PCT (correct two part form of the independent claims) are not met.

Re Item VIII
Certain observations on the international application

As far as understood, object of the present application is to improve the sensitivity of the known FAIMS or FIS spectrometers so that even very similar ions could be identified or separated. However, the present independent claims 1 and 10 only define method steps known e.g. from D2. Thus these claims lack method steps which are essential to the definition of the invention.

Since independent claims 1 and 10 do not contain such method steps, they do not meet the requirement following from Article 6 PCT taken in combination with Rule 6.3(b) PCT that any independent claim must contain all the technical features essential to the definition of the invention.

Analysis Division Symposium, Framingham, MA, 21-24 April 1996, p. 85; and B. Carnahan and A. Tarassov, U.S. Patent Number 5,420,424). Ions are separated in FAIMS on the basis of the difference in the mobility of an ion at high field K_h relative to its mobility at low field K. That is, the ions are separated because of the compound dependent behaviour of K_h as a function of the electric field. This offers a new tool for atmospheric pressure gas-phase ion studies since it is the change in ion mobility and not the absolute ion mobility that is being monitored.

An instrument based on the FAIMS concept has been designed and built by Mine Safety Appliances Company of Pittsburgh, Pa. ("MSA") for use in trace gas analysis. The MSA instrument is described in U.S. Patent No. 5,420,424 and is available under the trade mark FIS (for Field Ion Spectrometer). While the use of the MSA instrument (and similar instruments based on the FAIMS concept) for trace gas analysis is known, the inventors believe that they have identified certain heretofore unrealized properties of these instruments which make them more versatile. Based on this realization, the inventors have developed what is believed to be a previously unknown method for separation of isotopes of ions. A summary and detailed description of the present invention is provided below.

SUMMARY OF THE INVENTION

The present invention provides a method for identifying isotopes, comprising the steps of:

a) providing at least one ionization source for providing ions at least some of which are isotopes;

b) providing an analyzer region defined by a space between at least first and second spaced apart electrodes, said analyzer region being in communication with at least one of each of a gas inlet, a gas outlet, an ion inlet and an ion outlet, and introducing said ions into said analyzer region through said ion inlet;

c) applying an asymmetric waveform voltage and a direct current compensation voltage to at least one of said electrodes;

d) setting said asymmetric waveform voltage;

e) varying said direct current compensation voltage and measuring resulting transmitted ions at said ion outlet, so as to produce a compensation voltage scan for said transmitted ions;

f) identifying peaks in said compensation voltage scan corresponding to said isotopes; and

g) setting said direct current compensation voltage to correspond to one of said peaks, so as to separate and enrich a desired isotope.

Advantageously, the method is operable substantially at atmospheric pressure and substantially at room temperature.

The method may further include the step of detecting said transmitted ions by mass spectrometry.

Such transmitted ions may be subjected to a mass analysis scan to provide ion intensity data over a selected range of mass to charge ratios.

Typically, the method includes providing a gas flow through said analyzer region, so as to transport said ions along said analyzer region, although it will be understood that other ion transport means are possible.

Furthermore, in identifying a peak, it will be understood that the term peak is not limited to the apex of the peak, and that a peak will typically have a noticeable width, or a compensation voltage range in which the peak appears.

Finally, it will be understood that while mass spectrometry may be used for the purpose of compensation voltage scans, mass spectrometry is not necessary once the operating conditions have been determined. That is to say, isotopes separated and enriched by the above method may be collected for further processing.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the present invention, and by way of example, reference will now be made to the accompanying drawings, which show preferred embodiments of the present invention in which:

WE CLAIM:

1. A method for identifying isotopes, comprising the steps of:

a) providing at least one ionization source for providing ions at least some of which are isotopes;

b) providing an analyzer region defined by a space between at least first and second spaced apart electrodes, said analyzer region being in communication with at least one of each of a gas inlet, a gas outlet, an ion inlet and an ion outlet, and introducing said ions into said analyzer region through said ion inlet;

c) applying an asymmetric waveform voltage and a direct current compensation voltage to at least one of said electrodes;

d) setting said asymmetric waveform voltage;

e) varying said direct current compensation voltage and measuring resulting transmitted ions at said ion outlet, so as to produce a compensation voltage scan for said transmitted ions;

f) identifying peaks in said compensation voltage scan corresponding to said isotopes; and

g) setting said direct current compensation voltage to correspond to one of said peaks, so as to separate and enrich a desired isotope.

2. The method claimed in claim 1, which includes operating substantially at atmospheric pressure and substantially at room temperature.

3. The method claimed in claim 1 or 2, which includes generating said ions for said source of ions by electrospray ionization.

4. The method claimed in any preceding claim, which includes detecting said transmitted ions by mass spectrometry.

5. The method claimed in claim 4, which includes subjecting the

transmitted ions to a mass analysis scan to provide ion intensity data over a selected range of mass to charge ratios.

6. The method claimed in any preceding claim, which includes providing a gas flow through said analyzer region, so as to transport said ions along said analyzer region.

7. The method claimed in claim 1, wherein, step a) comprises providing isotopes of one of chlorine and bromine.

8. The method claimed in claim 7, wherein, step a) comprises providing the isotopes $^{35}Cl^-$ and $^{37}Cl^-$ for separation in step g).

9. The method claimed in claim 7, wherein, step a) comprises providing the isotopes $^{79}Br^-$ and $^{81}Br^-$ for separation in step g).

10. A method for separating and enriching ions of differing isotopic composition, comprising the steps of:

a) providing at least one ionization source for providing ions at least some of which are isotopes;

b) providing an analyzer region defined by a space between at least first and second spaced apart electrodes, said analyzer region being in communication with a gas inlet, a gas outlet, an ion inlet and an ion outlet, and introducing said ions into said analyzer region through said ion inlet;

c) applying an asymmetric waveform voltage and a direct current compensation voltage to at least one of said electrodes;

d) setting said asymmetric waveform voltage; and

e) setting said direct current compensation voltage to a determined value to separate and enrich a desired isotopic ion.

11. The method claimed in claim 10, which includes operating substantially at atmospheric pressure and substantially at room temperature.

12. The method claimed in claim 10, wherein, said ions introduced into said ion inlet are produced by electrospray ionization.

13. The method claimed in claim 10, which includes detecting said transmitted ions by mass spectrometry.

14. The method claimed in claim 10, which includes subjecting the transmitted ions to a mass analysis scan to provide ion intensity data over a selected range of mass to charge ratios.

15. The method claimed in any one of claims 10-14, which includes providing a gas flow through said analyzer region, so as to transport said ions along said analyzer region.

16. The method claimed in claim 10, wherein, said step a) comprises providing isotopes of one of chlorine and bromine.

17. The method claimed in claim 15, wherein, step a) comprises providing the isotopes $^{35}Cl^-$ and $^{37}Cl^-$.

18. The method claimed in claim 16, wherein, step a) comprises providing the isotopes $^{79}Br^-$ and $^{81}Br^-$.

19. The method claimed in claim 10, including the steps of:

f) varying said direct current compensation voltage and measuring resulting transmitted ions at said ion outlet, so as to produce a compensation voltage scan for said transmitted ions;

g) identifying peaks in said compensation voltage scan corresponding to

said desired isotopic ions; and

h) determining an appropriate direct current compensation voltage corresponding to one of said peaks, so as to separate and enrich a desired isotopic ion.

REPLACED BY ART 34 AMDT

Analysis Division Symposium, Framingham, MA, 21-24 April 1996, p. 85; and B. Carnahan and A. Tarassov, U.S. Patent Number 5,420,424). Ions are separated in FAIMS on the basis of the difference in the mobility of an ion at high field K_h relative to its mobility at low field K. That is, the ions are separated because of the compound dependent behaviour of K_h as a function of the electric field. This offers a new tool for atmospheric pressure gas-phase ion studies since it is the change in ion mobility and not the absolute ion mobility that is being monitored.

An instrument based on the FAIMS concept has been designed and built by Mine Safety Appliances Company of Pittsburgh, Pa. ("MSA") for use in trace gas analysis. The MSA instrument is described in U.S. Patent No. 5,420,424 and is available under the trade mark FIS (for Field Ion Spectrometer). While the use of the MSA instrument (and similar instruments based on the FAIMS concept) for trace gas analysis is known, the inventors believe that they have identified certain heretofore unrealized properties of these instruments which make them more versatile. Based on this realization, the inventors have developed what is believed to be a previously unknown method for separation of isotopes of ions. A summary and detailed description of the present invention is provided below.

SUMMARY OF THE INVENTION

The present invention provides a method for identifying isotopes, comprising the steps of:

a) providing at least one ionization source of ions at least some of which are isotopes;

b) providing an analyzer region defined by a space between at least first and second spaced apart electrodes, said analyzer region being in communication with a gas inlet, a gas outlet, an ion inlet and an ion outlet, and introducing said ions into said analyzer region through said ion inlet;

c) applying an asymmetric waveform voltage and a direct current compensation voltage to at least one of said electrodes;

d) setting said asymmetric waveform voltage;

e) varying said direct current compensation voltage and measuring resulting transmitted ions at said ion outlet, so as to produce a compensation voltage scan for said transmitted ions; and

f) identifying peaks in said compensation voltage scan corresponding to said isotopes.

The method may further comprise the step of setting said direct current compensation voltage to correspond to one of said peaks, so as to separate and enrich a desired isotope.

Advantageously, the method is operable substantially at atmospheric pressure and substantially at room temperature.

The method may further include the step of detecting said transmitted ions by mass spectrometry.

Such transmitted ions may be subjected to a mass analysis scan to provide ion intensity data over a selected range of mass to charge ratios.

Typically, the method includes providing a gas flow through said analyzer region, so as to transport said ions along said analyzer region, although it will be understood that other ion transport means are possible.

Furthermore, in identifying a peak, it will be understood that the term peak is not limited to the apex of the peak, and that a peak will typically have a noticeable width, or a compensation voltage range in which the peak appears.

Finally, it will be understood that while mass spectrometry may be used for the purpose of compensation voltage scans, mass spectrometry is not necessary once the operating conditions have been determined. That is to say, isotopes separated and enriched by the above method may be collected for further processing.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the present invention, and by way of example, reference will now be made to the accompanying drawings, which show preferred embodiments of the present invention in which:

WE CLAIM:

1. A method for identifying isotopes, comprising the steps of:

a) providing at least one ionization source of ions at least some of which are isotopes;

b) providing an analyzer region defined by a space between at least first and second spaced apart electrodes, said analyzer region being in communication with a gas inlet, a gas outlet, an ion inlet and an ion outlet, and introducing said ions into said analyzer region through said ion inlet;

c) applying an asymmetric waveform voltage and a direct current compensation voltage to at least one of said electrodes;

d) setting said asymmetric waveform voltage;

e) varying said direct current compensation voltage and measuring resulting transmitted ions at said ion outlet, so as to produce a compensation voltage scan for said transmitted ions; and

f) identifying peaks in said compensation voltage scan corresponding to said isotopes.

2. The method claimed in claim 1, further comprising the step of setting said direct current compensation voltage to correspond to one of said peaks, so as to separate and enrich a desired isotope.

3. The method claimed in claim 1 or 2, which includes operating substantially at atmospheric pressure and substantially at room temperature.

4. The method claimed in claim 1, 2 or 3, which includes generating said ions for said source of ions by electrospray ionization.

5. The method claimed in any preceding claim, which includes detecting said transmitted ions by mass spectrometry.

6. The method claimed in claim 5, which includes subjecting the transmitted ions to a mass analysis scan to provide ion intensity data over a selected range of mass to charge ratios.

7. The method claimed in any preceding claim, which includes providing a gas flow through said analyzer region, so as to transport said ions along said analyzer region.

8. The method claimed in claim 1, wherein, said isotopes are isotopes of one of chlorine and bromine.

9. The method claimed in claim 8, wherein, said isotopes are $^{35}Cl^-$ and $^{37}Cl^-$.

10. The method claimed in claim 8, wherein, said isotopes are $^{79}Br^-$ and $^{81}Br^-$.

11. A method for separating and enriching ions of differing isotopic composition, comprising the steps of:

a) providing at least one ionization source of ions;

b) providing an analyzer region defined by a space between at least first and second spaced apart electrodes, said analyzer region being in communication with a gas inlet, a gas outlet, an ion inlet and an ion outlet, and introducing said ions into said analyzer region through said ion inlet;

c) applying an asymmetric waveform voltage and a direct current compensation voltage to at least one of said electrodes;

d) setting said asymmetric waveform voltage; and

e) setting said direct current compensation voltage to a determined value to separate and enrich a desired isotopic ion.

12. The method claimed in claim 11, which includes operating substantially at atmospheric pressure and substantially at room temperature.

13. The method claimed in claim 11, wherein, said ions introduced into said ion inlet are produced by electrospray ionization.

14. The method claimed in claim 11, which includes detecting said transmitted ions by mass spectrometry.

15. The method claimed in claim 11, which includes subjecting the transmitted ions to a mass analysis scan to provide ion intensity data over a selected range of mass to charge ratios.

16. The method claimed in any one of claims 11-15, which includes providing a gas flow through said analyzer region, so as to transport said ions along said analyzer region.

17. The method claimed in claim 11, wherein, said isotopes are isotopes of one of chlorine and bromine.

18. The method claimed in claim 16, wherein, said isotopes are $^{35}Cl^-$ and $^{37}Cl^-$.

19. The method claimed in claim 16, wherein, said isotopes are $^{79}Br^-$ and $^{81}Br^-$.

20. The method claimed in claim 11, including the steps of:

a) varying said direct current compensation voltage and measuring resulting transmitted ions at said ion outlet, so as to produce a compensation voltage scan for said transmitted ions;

b) identifying peaks in said compensation voltage scan corresponding to said desired isotopic ions; and

c) determining an appropriate direct current compensation voltage corresponding to one of said peaks, so as to separate and enrich a desired isotopic ion.

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*** RX REPORT ***
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PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

BERESKIN & PARR
40th floor
40 King Street West
Toronto, Ontario M5H 3Y2
CANADA

PCT

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NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL PRELIMINARY EXAMINATION REPORT
(PCT Rule 71.1)

Date of mailing *(day/month/year)*	27.11.2000
Applicant's or agent's file reference	IMPORTANT NOTIFICATION
571-578	
International application No.	International filing date *(day/month/year)*
PCT/CA99/00716	05/08/1999
Priority date *(day/month/year)*	05/08/1998
Applicant	
NATIONAL RESEARCH COUNCIL CANADA et al.	

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.

2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.

3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. REMINDER

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/	Authorized officer
European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Weber, R Tel. +49 89 2399 2382

Form PCT/IPEA/416 (July 1998)

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
571-578		
International application No. PCT/CA99/00716	International filing date *(day/month/year)* 05/08/1999	Priority date *(day/month/year)* 05/08/1998
International Patent Classification (IPC) or national classification and IPC G01N27/64		
Applicant NATIONAL RESEARCH COUNCIL CANADA et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 8 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 6 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☒ Certain documents cited
   - VII ☒ Certain defects in the international application
   - VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
21/02/2000	27.11.2000
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel: +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Papantoniou, E Telephone No. +49 89 2399 2468

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/CA99/00716

I. Basis of the report

1. This report has been drawn on the basis of *(substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments (Rules 70.16 and 70.17).)*:

Description, pages:

1,4-24	as originally filed			
2,3	as received on	09/11/2000	with letter of	09/11/2000

Claims, No.:

1-19	as received on	09/11/2000	with letter of	09/11/2000

Drawings, sheets:

1/17-17/17	as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/CA99/00716

- ☐ the description, pages:
- ☐ the claims, Nos.:
- ☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1 - 19
	No:	Claims	
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1 - 19
Industrial applicability (IA)	Yes:	Claims	1 - 19
	No:	Claims	

2. Citations and explanations
see separate sheet

VI. Certain documents cited

1. Certain published documents (Rule 70.10)

and / or

2. Non-written disclosures (Rule 70.9)

see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/CA99/00716

claims are fully supported by the description, are made:
see separate sheet

INTERNATIONAL PRELIMINARY EXAMINATION REPORT - SEPARATE SHEET

International application No. PCT/CA99/00716

Re Item V

Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Reference is made to the following documents:

D1: RIEGNER ET AL: "Qualitative evaluation of field ion spectrometry for chemical warfare agent detection" PROCEEDINGS OF THE 45TH ASMS CONFERENCE ON MASS SPECTROMETRY AND ALLIED TOPICS , June 1997 (1997-06), pages 473a-473b, XP000865529 cited in the application
D2: BURYAKOV ET AL.: "A new method of separation of multi-atomic ions by mobility at atmospheric pressure using a high-frequency amplitude asymmetric strong electric field" INTERNATIONAL JOURNAL OF MASS SPECTROMETRY AND ION PROCESSES., vol. 128, 1993, pages 143-148, XP000865595 ELSEVIER SCIENTIFIC PUBLISHING CO. AMSTERDAM., NL ISSN: 0168-1176
D3: CARNAHAN B. ET AL.: "Field ion spectrometry - a new analytical technology for trace gas analysis" PROCEEDINGS OF THE 41ST ISA ANALYSIS DIVISION SYMPOSIUM , vol. 29, 21 - 24 April 1996, pages 85-94, XP000863733
D4: US 5 420 424 A (CARNAHAN BYRON L ET AL) 30 May 1995 (1995-05-30).
D5: HUDGINS R R ET AL: "High resolution ion mobility measurements for gas phase proteins: correlation between solution phase and gas phase conformations" INTERNATIONAL JOURNAL OF MASS SPECTROMETRY AND ION PROCESSES,NL,ELSEVIER SCIENTIFIC PUBLISHING CO. AMSTERDAM, vol. 165-166, page 497-507 XP004103206 ISSN: 0168-1176

2. Claim 1
D2, which is considered as the closest prior art, discloses a method for identifying ions. The method according to D2 comprises the steps of:
- providing at least one ionization source for providing ions (see the ionization chamber of Fig. 2, D2);
- providing an analyzer region defined by a space between at least a first and a second spaced apart electrodes, said analyzer region being in communication with a gas inlet, a gas outlet, an ion inlet and an ion outlet, and introducing said ions into said analyzer region through said ion inlet (see the ion separator of Fig. 2, D2);

- applying an asymmetric waveform voltage (of Fig. 1, D2) and a direct current compensation voltage (for producing E_c of equation 4 of page 145, left column, D2) to at least one of said electrodes;
- setting said asymmetric voltage (e.g. setting $E_s(t)$ of equation 4 of page 145, left column, D2);
- varying said direct current compensation voltage (see page 145, left column, lines 1 - 10, and eq. 6, D2) and measuring resulting transmitted ions at said ion outlet, so as to produce a compensation voltage scan for said transmitted ions (see page 145, left column, last paragraph, D2);
- identifying peaks in said compensation voltage scan (see Fig. 3, D2); and
- setting said direct current compensation voltage to correspond to one of said peaks (see page 146, left column, last paragraph, D2), so as to separate and enrich a desired ion (see page 147, right column, last paragraph, D2).

Although present claim 1 defines that the present method is suitable "for identifying isotopes" and is used "to separate and erich a desired isotope", while D2 is used for identifying and separating ions in general, nonetheless, the method of ion separation according to D2 is also suitable for isotope identification. Specifically since D2 states that it provides an improved method of ion separation even for ions with similar masses (see page 145, right column, last paragraph, D2), it would be obvious to the skilled person to use the method of D2 also for isotopes, specially as present claim 1 does not define any new method steps specifically used for isotopes.

Thus the subject matter of claim 1 is not inventive (Article 33(3) PCT).

3. It is also noted that the particular method steps, e.g. steps a - f, defined in present claim 1 are also known from the other search report documents D1, D3 and D4. See e.g. D1, Fig. 1 and 3 and page 473B, first two paragraphs, D1; D3 Fig. 2 and the two voltages shown in Fig. 1, D3; D4, columns 7 and 8, D4.

4. Claim 10
D2, which is considered as the closest prior art, discloses a method for separating ions (see the title of D2). The method according to D2 comprises the steps of:
a) providing at least one ionization source of ions (ionization chamber of Fig. 2,

D2);
b) providing an analyzer region (ion separator of Fig. 2, D2) defined by a space between at least a first and a second spaced apart electrodes, said analyzer region being in communication with a gas inlet (inlet of Fig. 2, see also page 144, right column, last paragraph, D2), a gas outlet (ion collector of Fig. 2, D2), an ion inlet and an ion outlet, and introducing said ions into said analyzer region through said ion inlet (see Fig. 2, D2);
- applying an asymmetric waveform voltage (of Fig. 1, D2) and a direct current compensation voltage (for producing E_c of equation 4 of page 145, left column, D2) to at least one of said electrodes;
- setting said asymmetric voltage (e.g. setting $E_s(t)$ of equation 4 of page 145, left column, D2);
- setting said direct current compensation voltage to a determined value (e.g. setting E_c of equation 4 of page 145, left column, D2) to separate the ions (see Fig. 3, D2).

Although present claim 10 defines that the present method is suitable "for separating and enriching ions of different isotopic composition", while D2 does not explicitly define such enrichment, nonetheless, D2 states that it provides an improved method for separating homologous ions (see page 148, section "Conclusions", D2). Thus the skilled person would find it obvious to use the method of D2 "for separating and enriching ions of different isotopic composition".

Thus the subject matter of claim 10 is not inventive (Article 33(3) PCT).

6. Dependent claims 2 - 9, 11 - 19, do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of inventive step, the reasons being as follows:

The method steps of claims 2, 6, 15, 19, are known from D1.
The method steps of claims 4, 11, are known from D2.
The method steps of claims 3, 4, 12 are known from D4 and D5 (see Fig. 1, D5).
The method steps of claims 4, 5, 13, 14 are known from D2 and D5.
Claims 7 - 9, 16 - 18, do not define concrete method steps but rather define what ions are investigated. Such wording is not inventive (Article 33(3) PCT).

INTERNATIONAL PRELIMINARY EXAMINATION REPORT - SEPARATE SHEET

International application No. PCT/CA99/00716

Re Item VI
Certain documents cited

The claimed priority could not be checked. It is therefore noted that in case the priority is not valid, document GUEVREMONT R ET AL: "High field asymmetric waveform ion mobility spectrometry-mass spectrometry: an investigation of leucine enkephalin ions produced by electrospray ionization" JOURNAL OF THE AMERICAN SOCIETY FOR MASS SPECTROMETRY,US,ELSEVIER SCIENCE INC., NEW YORK, NY, vol. 10, no. 6, page 492-501 XP004173039 ISSN: 1044-0305, could be used against the novelty or inventive step of the present claims.

Re Item VII
Certain defects in the international application

For the sake of completeness, it is mentioned that the requirements of Rule 6.3(b) PCT (correct two part form of the independent claims) are not met.

Re Item VIII
Certain observations on the international application

As far as understood, object of the present application is to improve the sensitivity of the known FAIMS or FIS spectrometers so that even very similar ions could be identified or separated. However, the present independent claims 1 and 10 only define method steps known e.g. from D2. Thus these claims lack method steps which are essential to the definition of the invention.

Since independent claims 1 and 10 do not contain such method steps, they do not meet the requirement following from Article 6 PCT taken in combination with Rule 6.3(b) PCT that any independent claim must contain all the technical features essential to the definition of the invention.

PATENT COOPERATION TREA

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	FOR FURTHER ACTION	see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.
571-578		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/CA 99/ 00716	05/08/1999	05/08/1998
Applicant		
NATIONAL RESEARCH COUNCIL CANADA et al.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

a. With regard to the **language,** the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

[ ] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

[ ] contained in the international application in written form.

[ ] filed together with the international application in computer readable form.

[ ] furnished subsequently to this Authority in written form.

[ ] furnished subsequently to this Authority in computer readble form.

[ ] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

[ ] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. [ ] **Certain claims were found unsearchable** (See Box I).

3. [ ] **Unity of invention is lacking** (see Box II).

4. With regard to the **title,**

[X] the text is approved as submitted by the applicant.

[ ] the text has been established by this Authority to read as follows:

5. With regard to the **abstract,**

[X] the text is approved as submitted by the applicant.

[ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. 5B

[ ] as suggested by the applicant.

[X] because the applicant failed to suggest a figure.

[ ] because this figure better characterizes the invention.

[ ] None of the figures.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/CA 99/00716

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G01N27/64 H01J49/04 H01J49/42 B01D59/48

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G01N H01J B01D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	GUEVREMONT R ET AL: "High field asymmetric waveform ion mobility spectrometry-mass spectrometry: an investigation of leucine enkephalin ions produced by electrospray ionization" JOURNAL OF THE AMERICAN SOCIETY FOR MASS SPECTROMETRY,US,ELSEVIER SCIENCE INC., NEW YORK, NY, vol. 10, no. 6, page 492-501 XP004173039 ISSN: 1044-0305 the whole document --- -/--	1,11

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22 December 1999	12/01/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Hulne, S

1

Form PCT/ISA/210 (second sheet) (July 1992)

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
Y	HUDGINS R R ET AL: "High resolution ion mobility measurements for gas phase proteins: correlation between solution phase and gas phase conformations" INTERNATIONAL JOURNAL OF MASS SPECTROMETRY AND ION PROCESSES,NL,ELSEVIER SCIENTIFIC PUBLISHING CO. AMSTERDAM, vol. 165-166, page 497-507 XP004103206 ISSN: 0168-1176 page 498 -page 499 ---	1,11
Y	RIEGNER ET AL: "Qualitative evaluation of field ion spectrometry for chemical warfare agent detection" PROCEEDINGS OF THE 45TH ASMS CONFERENCE ON MASS SPECTROMETRY AND ALLIED TOPICS , June 1997 (1997-06), pages 473a-473b, XP000865529 cited in the application the whole document ---	1,11
A	BURYAKOV ET AL.: "A new method of separation of multi-atomic ions by mobility at atmospheric pressure using a high-frequency amplitude asymmetric strong electric field" INTERNATIONAL JOURNAL OF MASS SPECTROMETRY AND ION PROCESSES., vol. 128, 1993, pages 143-148, XP000865595 ELSEVIER SCIENTIFIC PUBLISHING CO. AMSTERDAM., NL ISSN: 0168-1176 cited in the application figure 2 ---	1,11
A	CARNAHAN B. ET AL.: "Field ion spectrometry - a new analytical technology for trace gas analysis" PROCEEDINGS OF THE 41ST ISA ANALYSIS DIVISION SYMPOSIUM , vol. 29, 21 - 24 April 1996, pages 85-94, XP000863733 cited in the application figure 2 ---	1,11
A	US 5 420 424 A (CARNAHAN BYRON L ET AL) 30 May 1995 (1995-05-30) cited in the application abstract -----	1,11

1

INTERNATIONAL SEARCH REPORT

[redacted]rmation on patent family members

International Application No
PCT/CA 99/00716

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5420424 A	30-05-1995	CA 2148166 A	30-10-1995
		EP 0679886 A	02-11-1995
		FI 951910 A	30-10-1995
		IL 113468 A	20-11-1997
		JP 8054373 A	27-02-1996

PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 :
G01N 27/64, H01J 49/04, 49/42, B01D 59/48

A1

(11) International Publication Number: WO 00/08456

(43) International Publication Date: 17 February 2000 (17.02.00)

(21) International Application Number: PCT/CA99/00716

(22) International Filing Date: 5 August 1999 (05.08.99)

(30) Priority Data:

60/095,481	5 August 1998 (05.08.98)	US
2,260,572	29 January 1999 (29.01.99)	CA
09/321,820	28 May 1999 (28.05.99)	US

05 Feb 01 /30 Mon

(71) Applicant *(for all designated States except US)*: NATIONAL RESEARCH COUNCIL CANADA [CA/CA]; 1500 Montreal Road, Ottawa, Ontario K1A 0R6 (CA).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: GUEVREMONT, Roger [CA/CA]; 2059 Gatineau View Cr., Gloucester, Ontario K1J 7W9 (CA); PURVES, Randy, W. [CA/CA]; 59–6247 Sundown Cr., Gloucester, Ontario K1C 2M1 (CA); BARNETT, David [CA/CA]; 1934 Longman Cr., Orleans, Ontario K1C 5G6 (CA).

(74) Agent: BERESKIN & PARR; 40th floor, 40 King Street West, Toronto, Ontario M5H 3Y2 (CA).

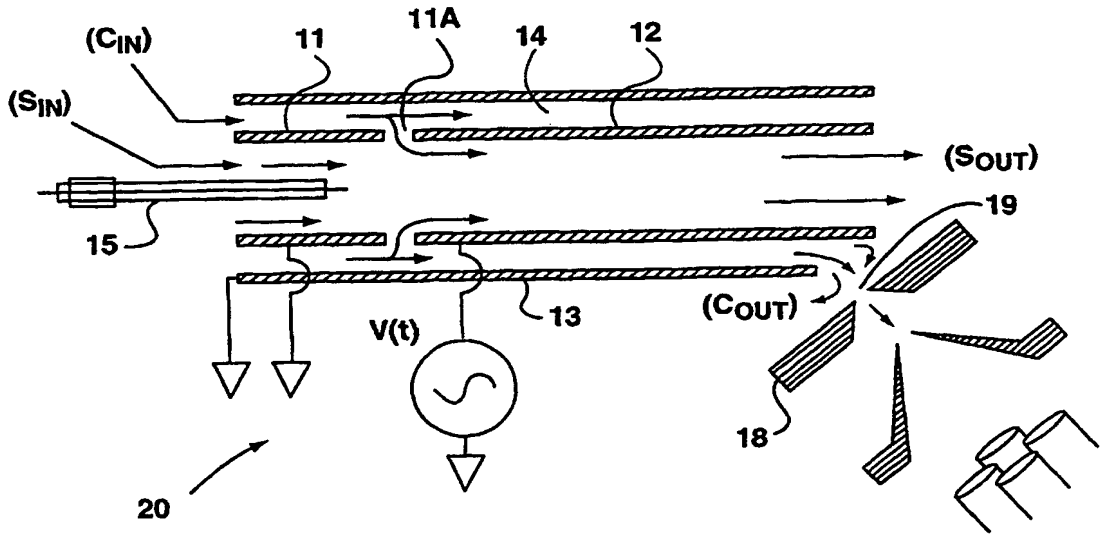
(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published

With international search report.

Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: METHOD FOR SEPARATION AND ENRICHMENT OF ISOTOPES IN GASEOUS PHASE



(57) Abstract

The present invention relates to a method for separating and enriching stable isotopes in gas phase using the principles of high field asymmetric waveform ion mobility spectrometry, substantially at atmospheric pressure (760 torr) and substantially at room temperature (298 K). Specifically, the method of the present invention may be used to separate and enrich isotopes of chlorine. Electrospray ionization may be used to generate a gaseous mixture of ions and the ion beam exiting the high field asymmetric waveform ion mobility spectrometer may be sampled into a mass spectrometer for isotope identification.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

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TR	Turkey
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UG	Uganda
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UZ	Uzbekistan
VN	Viet Nam
YU	Yugoslavia
ZW	Zimbabwe

INTERNATIONAL SEARCH REPORT

Inte ional Application No
PCT/CA 99/00716

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G01N27/64 H01J49/04 H01J49/42 B01D59/48

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G01N H01J B01D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	GUEVREMONT R ET AL: "High field asymmetric waveform ion mobility spectrometry-mass spectrometry: an investigation of leucine enkephalin ions produced by electrospray ionization" JOURNAL OF THE AMERICAN SOCIETY FOR MASS SPECTROMETRY,US,ELSEVIER SCIENCE INC., NEW YORK, NY, vol. 10, no. 6, page 492-501 XP004173039 ISSN: 1044-0305 the whole document --- -/--	1,11

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22 December 1999	12/01/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Hulne, S

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Form PCT/ISA/210 (second sheet) (July 1992)

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
Y	HUDGINS R R ET AL: "High resolution ion mobility measurements for gas phase proteins: correlation between solution phase and gas phase conformations" INTERNATIONAL JOURNAL OF MASS SPECTROMETRY AND ION PROCESSES,NL,ELSEVIER SCIENTIFIC PUBLISHING CO. AMSTERDAM, vol. 165-166, page 497-507 XP004103206 ISSN: 0168-1176 page 498 -page 499 ---	1,11
Y	RIEGNER ET AL: "Qualitative evaluation of field ion spectrometry for chemical warfare agent detection" PROCEEDINGS OF THE 45TH ASMS CONFERENCE ON MASS SPECTROMETRY AND ALLIED TOPICS , June 1997 (1997-06), pages 473a-473b, XP000865529 cited in the application the whole document ---	1,11
A	BURYAKOV ET AL.: "A new method of separation of multi-atomic ions by mobility at atmospheric pressure using a high-frequency amplitude asymmetric strong electric field" INTERNATIONAL JOURNAL OF MASS SPECTROMETRY AND ION PROCESSES., vol. 128, 1993, pages 143-148, XP000865595 ELSEVIER SCIENTIFIC PUBLISHING CO. AMSTERDAM., NL ISSN: 0168-1176 cited in the application figure 2 ---	1,11
A	CARNAHAN B. ET AL.: "Field ion spectrometry - a new analytical technology for trace gas analysis" PROCEEDINGS OF THE 41ST ISA ANALYSIS DIVISION SYMPOSIUM , vol. 29, 21 - 24 April 1996, pages 85-94, XP000863733 cited in the application figure 2 ---	1,11
A	US 5 420 424 A (CARNAHAN BYRON L ET AL) 30 May 1995 (1995-05-30) cited in the application abstract -----	1,11

1

ERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/CA 99/00716

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5420424 A	30-05-1995	CA 2148166 A	30-10-1995
		EP 0679886 A	02-11-1995
		FI 951910 A	30-10-1995
		IL 113468 A	20-11-1997
		JP 8054373 A	27-02-1996

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP01/05542

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] A61K33/00, 31/02, 31/409, 9/08, 47/02, G02C7/04, 13/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[7] A61K33/00, 31/02, 31/409, 9/08, 47/02, G02C7/04, 13/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1926-1992 Toroku Jitsuyo Shinan Koho 1994-1996
Kokai Jitsuyo Shinan Koho 1971-1992 Jitsuyo Shinan Toroku Koho 1996-2001

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
CA (STN), MEDLINE (STN), EMBASE (STN)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 254413 A2 (MATSUO, Yoshiaki), 27 January, 1988 (27.01.88), Claims 17, 18 & JP 63-112521 A	1-6,10-16
X	EP 89815 A1 (Haldt, Sterling Joel), 28 September, 1983 (28.09.83),	1-8,10-17
Y	Full text & JP 58-219125 A & US 4452818 A	9
Y	WO 96/3426 A1 (Duke University), 08 February, 1996 (08.02.96), page 2, line 3; page 4, line 25 & JP 10-503489 A	9
Y	JP 2000-175595 A (T. FURUYA), 27 June, 2000 (27.06.00), Par. Nos. [0013], [0028] (Family: none)	9

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
19 September, 2001 (19.09.01)	02 October, 2001 (02.10.01)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

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